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(54) Feed additive composition

(57) A feed additive having a high utilization efficiency obtained by mixing and granulating one or more substances effective for a ruminant together with at least 20 wt. % of a water-insoluble salt of an acid, which is less acidic than hydrochloric acid and is acceptable to the ruminant and at least 10 wt % of at least one material selected from straight-chain or branched, saturated or unsaturated monocarboxylic acids having at least 14 carbon atoms and salts thereof, animal fats having melting points of at least 40°C, vegetable fats having melting points of at least 40°C and waxes having melting points of at least 40°C.

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SPECIFICATION

Feed additive composition

This invention relates to a feed additive composition for a ruminant. More specifically, it relates to a feed additive composition featuring protection of one or more substances effective for a ruminant so as to permit the substantially unaltered passage of the substances through its rumen for their dissolution in its abomasum and subsequent tract.

A ruminant allows a variety of microorganisms to live together in symbiosis in its rumen and makes use of their activities to digest and use ingredients such as cellulose, which cannot inherently be used by higher animals. The existence and function of the rumen have extremely important significance for the ruminant. Through physiological and/or nutriological researches on ruminants, the existence of rumens have been pointed out as one of causes for the limited productivity of ruminants in recent years. As a result, a great deal of work is now under way with a view toward allowing one or more substances effective for a ruminant, the consumption of which substances in the rumen is not desired, to pass through the rumen substantially unaltered and to undergo disintegration and absorption in the abomasum and its subsequent digestive tract so that the effective substances can be used more efficiently. There is also a standing desire from the animal husbandry, which is seeking more efficient management, for the development of a technique which permits the substantially unaltered passage of such effective substances through the rumen. Some techniques have already been proposed. None of such techniques appear to be fully effective. For example, German Patent No. 22 12 568 discloses a biologically-effective granular substance coated with an aliphatic monocarboxylic acid having 14–22 carbon atoms or ricinoleic acid, or with coating films of such an acid mixture or a salt of such an acid or acid mixture.

On the other hand, Japanese Patent Publication No. 1057/1981 discloses a biologically-active substance coated with a matrix formed of a saturated, straight-chain or branched, substituted or unsubstituted, aliphatic monocarboxylic acid having at least 14 carbon atoms or a salt thereof, or a mixture of the saturated acid or its salt and an unsaturated, straight-chain or branched, substituted or unsubstituted, aliphatic monocarboxylic acid having at least 14 carbon atoms or a salt thereof.

Japanese Patent Laid-open No. 154956/1981 discloses a biologically-effective granular substance equipped with coating films containing an aliphatic monocarboxylic acid having 14–22 carbon atoms or a mixture of salts of some of aliphatic monocarboxylic acids having 14–22 carbon atoms. Reference may also be made to Japanese Patent Laid-open No. 175449/1983, which discloses a biologically-active substance enclosed by coating films of a protective material which contains one or more materials selected from straight-chain or branched, saturated or unsaturated monocarboxylic acids, hydrogenated vegetable fats and hydrogenated animal fats, and chitosan.

The techniques of German Patent No. 22 12 568 and Japanese Patent Publication No. 1057/1981 are however accompanied by such drawbacks that the time available for the digestion and absorption is too short to achieve sufficient digestion and absorption, because it is primarily intended to effect the degradation of the coating materials in the small intestine and its subsequent digestive tract. In Japanese Patent Laid-open Nos. 154956/1981 and 175449/1983, there are used with a view toward overcoming the above-mentioned drawbacks such coating materials that disintegrate to allow one or more substances, effective for ruminants, to be dissolved out in the abomasum. However, the effectiveness of the techniques cannot be considered to be stable since the degradation of the coating materials in the abomasum does not proceed sufficiently. Under the circumstances, there is still no satisfactory feed additive composition which can pass through the rumen substantially unaltered and can be dissolved out in the abomasum and its subsequent digestive tract.

It is desirable to provide a feed additive composition which can protect one or more substances effective for a ruminant and undesirable to be consumed in the rumen, for example, amino acids, proteins, vitamins, enzymes, carbohydrates, drugs for animal use, hormones and/or the like so as to allow them to reach the abomasum for their digestion and/or absorption in the abomasum and its subsequent digestive tract while minimizing their loss in the rumen as much as possible, thereby to improve the utilization efficiency of such effective substances.

According to the present invention, a feed additive composition is obtained by granulating the one or more substances effective for the ruminant together with a water-insoluble salt of an acid, which is less acidic than hydrochloric acid and is acceptable to the ruminant, in an amount of at least 20 wt.% based on the whole weight of the feed additive composition and at least one material, which is selected from straight-chain or branched, saturated or unsaturated monocarboxylic acids having at least 14 carbon atoms and salts thereof, animal fats having melting points of at least 40°C, vegetable fats having melting points of at least 40°C and waxes having

melting points of at least 40°C, in a total amount of at least 10 wt.% based on the whole weight of the feed additive composition.

The feed additive composition of this invention may be applied to ruminants, including as typical examples beef cattle, dairy cattle, calves, sheet, goats and so on.

The term "at least one substance effective for a ruminant" or "one or more substances effective for a ruminant" as used herein means nourishment, livestock feed and/or drugs which are desirably absorbed at the abomasum and its subsequent digestive tract effectively into the body of the ruminant *per se* without being subjected to consumption in the rumen. Illustrative of such substances include amino acids, amino acid derivatives, proteins, vitamins, enzymes, carbohydrates, drugs for animal use, hormones, etc. Their representative examples are: as amino acids, methionine, lysine, threonine, leucine, isoleucine, phenylalanine, valine, and glycine; as amino acid derivatives, for example, N-acylamino acids, e.g., N-stearoylmethionine, N-oleoylmethionine, the calcium salt of N-hydroxymethylmethionine, lysine hydrochloride, methionine hydroxy analogues and sodium glutamate; as proteins, feather meal, fish meal, casein, corn protein and potato proein; as vitamins, vitamin A_1, vitamin A palmitate, vitamin A acetate, β-carotene, vitamin D_2, vitamin D_3, vitamin E, menadione sodium bisulfite, a group of vitamin B's (thiamine, thiamine hydrochloride, riboflavin, nicotinic acid, nicotinic acid amide, calcium pantothenate, pyridoxine hydrochloride, choline chloride, cyanocobalamine, biotin, folic acid and p-aminobenzoic acid; as enzymes, protease preparation, amylase preparation, mixed enzyme preparation and lipase preparation; as carbohydrates, starch, glucose, and sucrose; as drugs for animal use, antibiotics such as tetracyclines, aminoglycosides, macrolides, polypeptides, polysaccharides and polyethers, vermifuges such as Negphone, and antiparasitics such as piperazine salts; and as hormones, estrous hormones such as estrogen, stilbestrol and hexestrol, and thyroid hormones such as tyrotropin and goitrogen.

Usually, such effective substances are used singly. However, two or more of such effective substances may also be used in combination as a mixture.

As mentioned above, this invention also makes use of a water-insoluble salt of an acid which is less acidic than hydrochloric acid and is acceptable to a ruminant. Illustrative of such a water-insoluble salt may embrace calcium carbonate, calcium tertiary phosphate, calcium secondary phosphate, magnesium tertiary phosphate, zinc phosphate, aluminum phosphate, calcium silicate, calcium pyrophosphate, magnesium carbonate, lead carbonate, cobalt carbonate, etc. Usually, they are used singly. However, a mixture of two or more of such exemplary water-insoluble salts may also be employed.

In the present invention, the water-insoluble salt is used in an amount of at least 20 wt.% based on the whole weight of the feed additive composition. Any amounts smaller than 20 wt.% render the effective substance or substances difficult to be dissolved in the abomasum. It should not be contained at any unduly-high concentration, because such a high concentration renders the content of the effective substance or substances too low to achieve sufficient effects.

On the other hand, the content of at least one material, which is selected from straight-chain or branched, saturated or unsaturated monocarboxylic acids having at least 14 carbon atoms and salts thereof, animal fats having melting points of at least 40°C, vegetable fats having melting points of at least 40°C and waxes having melting points of at least 40°C, is at least 10 wt.% based on the whole weight of the feed additive composition. If its content should be less than 10 wt.%, the stability of the substance or substances effective for the ruminant in the rumen will be impaired so much that no significant effects will be brought about. If its content should be increased excessively, there will be such problems that the content of the effective substance or substances will correspondingly be lowered and its or their dissolution in the abomasum will be rendered difficult. Thus, it will be unable to achieve any significant effects.

As methods useful for the granulation of the feed additive composition of this invention, may be mentioned compacting granulation methods such as the rolling granulation method, extrusion-granulating method and tableting, the melt granulation method, the spray granulation method, the flow granulation method, the grinding granulation method and the agitation-granulating method. Using either one of such granulation methods, the feed additive composition of this invention may be formed into pellets, granules or tablets. In some instances, a binder or the like may also be incorporated.

The feed additive composition of this invention is generally used by adding it directly to livestock feed. It may however be added and mixed in advance, for example, upon production of formula feed.

As has been described above, the feed additive composition of this invention is extremely useful from the industrial viewpoint, as it has such excellent properties that its loss in the rumen of a ruminant is little and its digestion and/or absorption takes place in the abomasum and its subsequent digestive tract, and where the water-insoluble salt of the acid less acidic than hydrochloric acid and acceptable to th ruminant is calcium carbonate, the calcium carbonate is effective also as a calcium source.

Examples 1–4 & Comparative Example 1:

After intimately mixing in a ribbon mixer DL-methionine, stearic acid and a water-insoluble salt at their respective proportions given in Table 1, pellets of 2 mm across and 3 mm long were produced using a pelletizer. Using the thus-obtained pellet-like feed additive composition, leaching tests were conducted on DL-methionine in an artificial ruminal juice and an artificial abomasal juice. As the artificial ruminal juice, was used a 0.1-M sodium phosphate buffer. On the other hand, a 0.1-N hydrochloric acid was employed as the artificial abomasal juice. Each of the leaching tests was carried out in the following manner. 5 g of the above-prepared pellets was immersed in 100 ml of the artificial ruminal or abomasal juice placed in an Erlenmeyer flask. It was then maintained at 39°C on a shaker. After shaking it for a predetermined time period, the amount of DL-methionine leached out from the pellets into the corresponding juice was measured by the iodometric titration method. The shaking time was set at 10 hours in the case of the artificial ruminal juice and at 3 hours in the case of the artificial abomasal juice.

Compositions of the Examples and Comparative Example and results of the leaching tests in the Examples and Comparative Example are summarized in Table 1. In these Examples and subsequent Examples, all designations of "part or parts" and "%" mean part or parts by weight and wt.% respectively.

Examples 5 and 6:

In the same manner as in Examples 1–4, pellets containing nicotinic acid amide were produced. The amounts of leached-out nicotinic acid amide in the artificial ruminal and abomasal juices were measured by measuring the respective N contents in accordance with the Kjeldahl mehtod. Compositions and results are shown in Table 2.

Table 1

No.		Composition: DL-methionine (%)	Stearic acid (%)	Water-insoluble salt (%)	Leached-out methionine*: In artificial ruminal juice (%) [A]	In artificial abomasal juice (%) [B]	[B] - [A] (%)
Example	1	25	50	25**	13	72	59
	2	20	15	65**	26	88	62
	3	25	25	50**	18	85	67
	4	25	25	50***	21	86	65
Comp. Ex. 1		25	65	10**	8	35	27

* Expressed in terms of % of leached-out DL-methionine based on whole DL-methionine.
** Calcium tertiary phosphate.
*** Calcium secondary phosphate.

Table 2

Example	Composition: Nicotinic acid amide (%)	54°C hydrogenated oil (%)	Calcium tertiary phosphate (%)	Leached-out nicotinic acid amide*: In artificial ruminal juice (%) [A]	In artificial abomasal juice (%) [B]	[B] - [A] (%)
5	25	25	50	20	83	63
6	20	15	65	26	87	61

* Expressed in terms of % of leached-out nicotinic acid amide based on whole nicotinic acid amide.

Examples 5–8 & Comparative Example 2 and 3:

After intimately mixing in a ribbon mixer DL-methionine, 54°C hydrogenated oil and calcium carbonate at their respective proportions given in Table 1, pellets of 2 mm across and 3 mm long were produced using a pelletizer. Using the thus-obtained pellet-like feed additive composition, leaching tests were conducted on DL-methionine in an artificial ruminal juice and an artificial abomasal juice. As the artificial ruminal juice, was used a 0.1-M sodium phosphate buffer. On the other hand, a 0.1-N hydrochloric acid was employed as the artificial abomasal juice. Each of the leaching tests was carried out in the following manner. Namely, 5 g of the above-prepared pellets was immersed in 100 ml of the artificial ruminal or abomasal juice placed in an Erlenmeyer flask. It was then maintained at 39°C on a shaker. After shaking it for a predetermined time period, the amount of DL-methionine leached out from the pellets into the corresponding juice was measured by the iodometric titration method. The shaking time was set at 10 hours in the case of the artificial ruminal juice and at 3 hours in the case of the artificial abomasal juice.

Compositions of the Examples and Comparative Examples and results of the leaching tests in the Examples and Comparative Examples are summarized in Table 3.

Example 9:

Using 25 wt. % of DL-methionine, 25 wt.% of stearic acid and 50 wt.% of calcium carbonate, pellets were produced in the same manner as in Examples 1–4. A leaching test was carried out on the pellets. The amount of leached-out methionine was 17% in the artificial ruminal juice and 84% in the artificial abomasal juice.

Examples 10 and 11:

In the same manner as in Examples 5–9, pellets containing nicotinic acid amide were produced. A leaching test was conducted on the pellets. The amounts of leached-out nicotinic acid amide were determined by measuring the N contents in the artifical ruminal and abomasal juices in accordance with the Kjeldahl method. Composition and results are given in Table 4.

Table 3

No.		Composition			Leached-out methionine*		[B] - [A] (%)
		DL-methionine (%)	54°C hydrogenated oil (%)	Calcium carbonate (%)	In artificial ruminal juice (%) [A]	In artificial abomasal juice (%) [B]	
Example	5	25	25	50	15	85	70
	6	25	35	40	12	83	71
	7	30	15	55	21	87	66
	8	30	50	20	12	70	58
Comp. Ex.	2	25	70	5	8	13	5
	3	25	65	10	10	18	8

* Expressed in terms of % of leached-out DL-methionine based on whole DL-methionine.

Table 4

Example	Composition			Leached-out nicotinic acid amide*		[B] - [A] (%)
	Nicotinic acid amide (%)	54°C hydrogenated oil (%)	Calcium carbonate (%)	In artificial ruminal juice (%) [A]	In artificial abomasal juice (%) [B]	
10	25	25	50	18	89	71
11	30	35	35	17	85	68

* Expressed in terms of % of leached-out nicotinic acid amide based on whole nicotinic acid amide.

CLAIMS

1. A granulated feed additive composition containing at least one substance effective for a ruminant and capable of passing through the rumen of the ruminant substantially unaltered, said composition further comprising a water-insuluble salt of an acid, which is less acidic than hydrochloric acid and is acceptable to the ruminant, in an amount of at least 20 wt.% based on the whole weight of the feed additive composition, and at least one material, which is selected from straight-chain or branched, saturated or unsaturated monocarboxylic acids having at least 14 carbon atoms and salts thereof, animal fats having melting points of at least 40°C, vegetable fats having melting points of at least 40°C and waxes having melting points of at least 40°C, in a total amount of at least 10 wt.% based on the whole weight of the feed additive composition.

2. A feed additive composition as claimed in claim 1, wherein the water-insoluble salt is calcium carbonate.

3. A feed additive composition substantially as described herein.

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